Physics 131 HW II Solutions

1. We can use proportional reasoning:

$$\frac{9.8\,N}{2.2\,lbs} = \frac{x\,N}{165\,lbs} \Rightarrow x\,N = \frac{165 \cdot 9.8}{2.2}\,N = 735\,N$$

2. We found acceleration was proportional to force, but inversely proportional to mass. So, for the same [desired] acceleration, a heavy object (like a car) requires more force

3. We know $v = at$ if we start at rest, and $\Delta x = \frac{1}{2}at^2$ if we start at rest. We want $v = 1\,m/s$, and $\Delta x = 20\,m$, so, we know

$$1\,m/s = at \quad \text{and} \quad 20m = \tfrac{1}{2}at^2.$$

We want to find a, so eliminate t:

$$t = \frac{1\,m/s}{a} \Rightarrow 20m = \frac{1}{2}at^2 = \frac{1}{2}a\left(\frac{1\,m/s}{a}\right)^2$$

$$20m = \frac{1}{2}\,m^2/s^2 \cdot \frac{1}{a} \Rightarrow a = \frac{\frac{1}{2}\,m^2/s^2}{20m}$$

$$= \frac{1}{40}\,m/s^2$$

$$\boxed{a = .025\,m/s^2}$$

4. $a = \frac{F}{m} = \frac{500N}{1000kg} = \boxed{.5\,m/s^2}$

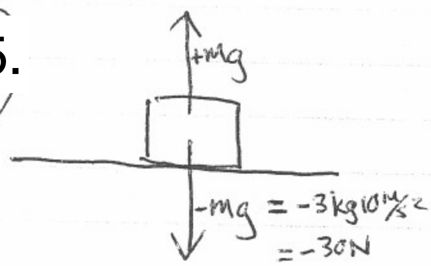
$v = at$ if starting from rest, so if $v = 1.5\,m/s$

$t = \frac{v}{a} = \frac{1.5\,m/s}{.5\,m/s^2} = \boxed{3\text{ sec}}$

$\Delta x = \frac{1}{2}at^2$ if starting from rest, so in 3 sec w/ $a = .5\,m/s^2$

$\Delta x = \frac{1}{2}(.5\,m/s^2)(3\,sec)^2 = \frac{9}{4}\,m = \boxed{2.25\,m}$

5.



Since $a = 0$ for the block, $F_{net} = 0$. The table must push up on the block just enough to balance the gravity force

6. We know for a spring $F = -kx$,

So, if 100g weight stretches the spring 1.2cm to equilibrium, then $F_{grav} = (.1kg)(10\,m/s^2) = 1N$ must be just balanced by the spring, so $k = \frac{-F}{x} = \frac{1N}{1.2cm} = \frac{1N}{.012m} = 83\,N/m$.

Now, an unknown object stretches it 6.3cm. So

$F_{spring} = -F_{grav} = .063m \cdot 83\frac{N}{m} = 5.25N$. This must be mg, so

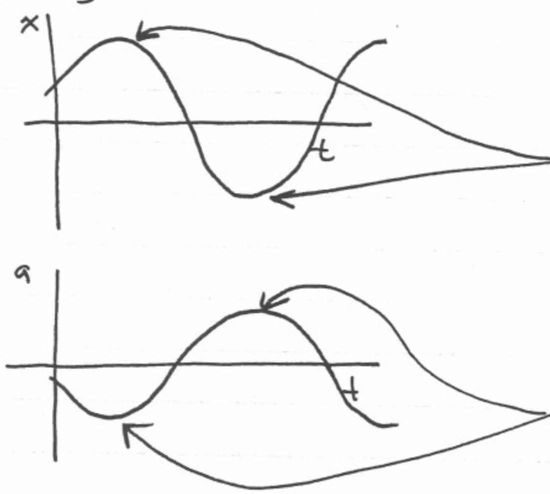
$m = \frac{5.25N}{10\,m/s^2} = .525\,kg = \boxed{525g}$

Or, could just use proportionality:

$\frac{100g}{1.2cm} = \frac{x\,g}{6.3cm} \Rightarrow x = \frac{6.3}{1.2} \cdot 100 = 525g$

7. Spring force

a)

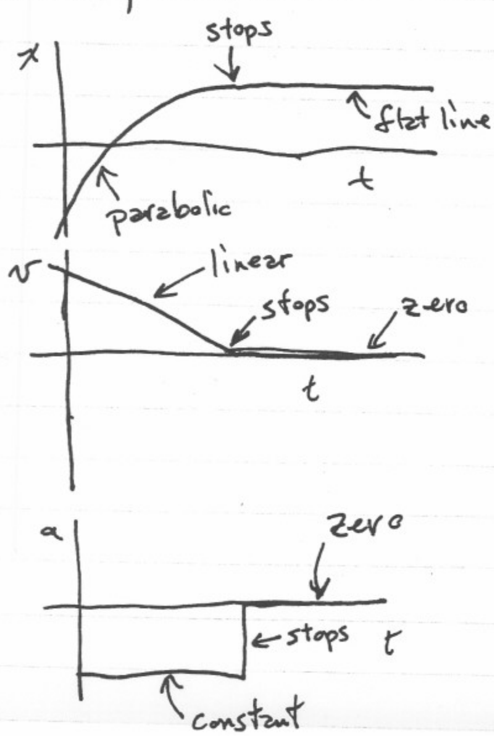


b) largest position (absolute value) occurs

largest acceleration (abs. val.) occurs

c) These extreme values in x occur at the same time as the extreme values in a. This makes sense, since Newton II ($F=ma$) and Hooke's Law ($F=-kx$) are both true, so $a=-\frac{k}{m}x$, so a is proportional to x

8. Sliding friction



9. $v(t)=5\cos(4t)$

a) What is $x(0)$? We can integrate to

$$x(t)=\int v(t)\,dt = \frac{5}{4}\sin(4t)+C$$

But we can't know C from $v(t)$, so we can't tell $x(0)$

b) What is $a(0)$? Differentiate:

$$a(t)=\frac{dv}{dt}=-20\sin(4t)$$

So $a(0)=-20\sin(0)=0$